

# Chapter 7

## Reservoir

### 7.1 Fixation of storage and Reservoir levels

With a view to provide irrigation to the areas lying in the upper part of Vaippar basin which need the facilities most, the water is to be delivered on Tamil Nadu side at high elevation as feasible. Keeping this in view, the live storages of the reservoirs on Pamba Kal Ar and Achankovil Kal Ar have been fixed to derive the optimum benefits. Optimisation studies were also carried out for this purpose.

The area and capacities of the reservoirs have been worked out. The gross storage capacity of Punnamedu dam at FRL + 246.0 m is 208 Mm<sup>3</sup> and live storage capacity is 118.5 Mm<sup>3</sup>. The minimum draw down level of Punnamedu reservoir has been fixed at 212.70 m considering the FRL of Achankovil Kal Ar (210 m) dam to which the Punnamedu-Achankovil Kal Ar interconnecting tunnel has to transfer the water. The bed level of the tunnel at off take is 211.25 m and at exit is 207.25 m. The maximum water level has been fixed at 247.0 m after the flood routing studies, while the top of dam is kept at 250.0 m.

The Achankovil Kal Ar reservoir will have a gross storage capacity of 496.90 Mm<sup>3</sup> at FRL 210 m and live storage capacity of 184.9 Mm<sup>3</sup>. The minimum draw down level of Achankovil Kal Ar reservoir is kept at 192.18 m, keeping in view the elevation of command area to which water is to be delivered. (The general elevation of command area lies in the range of 170 m to 130 m). The maximum water level of the reservoir is fixed at 210.829 m as per flood routing studies. The top of dam is 215.0 m.

The gross storage capacity of Achankovil pumped storage is 27.9 Mm<sup>3</sup>. The minimum draw down level of the reservoir is kept at 50.0 m, while the maximum water level and top of dam are 66.0 m and 69.0 m.

### 7.2 Sedimentation data and studies

The CWC has a gauge, discharge and silt observation station on Achankovil River at Thumpamon located 49 km downstream of Achankovil dam. The sediment data at the station is available from 1981-82 onwards. The details of sediment (course, medium and fine) for the available period are furnished below:

## Sediment load observed at Thumpamon G,D&S Site

Catchment area : 810 km<sup>2</sup>

Sl. No.	Year	Sediment				(Suspended load)			
		Coarse		Medium		Fine		Total	
		Metric Tons	ham	MT	ham	MT	ham	MT	ham
1.	1981-82	10997	0.567	19698	1.527	116314	12.116	147009	14.210
2.	1982-83	1736	0.089	6783	0.526	42877	4.466	51396	5.081
3.	1983-84	2445	0.126	5751	0.446	31279	3.258	39475	3.830
4.	1984-85	2058	0.106	5160	0.400	28988	3.020	36206	3.526
Total		17236	0.888	37392	2.899	219458	22.860	274086	26.647
Average for 4 years		4309	0.222	9348	0.725	54864.5	5.715	68521.5	6.662
Percentage		6.29		13.64		80.07		-	

*Note: The density of sediment for calculating volume of sediment has been worked out as per C.R. Millers formula.*

### 7.2.1 Rates of sedimentation

The total quantity of sediment from the suspended load works out to 26.647 ham for 4 years and the average sediment comes to 6.662 say 6.7 ham for a total catchment of 810 km<sup>2</sup>. Assuming the bed load of sediment as 15% of suspended load, the total of both suspended and bed load works out to 7.7 (6.7 + 1.000) ham per year for 810 km<sup>2</sup> or 0.010 ham / year / km<sup>2</sup>.

### 7.2.2 Sedimentation fractions expected

From the sediment data observed at Thumpamon G,D&S site for the period 1981-82 to 1984-85, the fractions of coarse, medium and fine varieties of sediment for suspended load per year are noted below :

Sl.No.	Sediment	Suspended load / ham		Bed load / ham
1)	Coarse	0.222	(6.29 %)	Assumed at 15% of suspended load
2)	Medium	0.725	(13.64%)	
3)	Fine	5.715	(80.07%)	
Total		6.662		1.000

### 7.2.3 Quantity of sediment load

Adopting the rate of sediment of 0.01 ham / year / km<sup>2</sup> observed at Thumpamon site and assuming the life of reservoir, as 100 years, the total

quantity of sediment during the life of reservoir works out to 135 ham, 189 ham and 145 ham respectively for Punnamedu, Achankovil Kal Ar and Achankovil pumped storage scheme respectively. However in the absence of long term observed sediment data and also due to non-availability of sediment data at the proposed dam sites, an average sediment rate of 5 ham / 100 km<sup>2</sup> / year has been assumed in the present study keeping in view the nature of terrain in which these dams are proposed. With the sediment rate of 5 ham / 100 km<sup>2</sup> / year and 15% bed load, the total sediment load for 100 years i.e., during the life of reservoirs works out to 776.25 ham, 1086.75 ham and 833.75 ham respectively for Punnamedu, Achankovil Kal Ar and Achankovil pumped storage scheme. With a trap efficiency of 98%, 98% and 75%, the sediment trapped in 100 years works out to 760.7 ham, 1065 ham and 625 ham in the Punnamedu, Achankovil Kal Ar and Achankovil reservoirs. The corresponding sediment loads at these reservoirs for 50 years are 380.4 ham, 532.5 ham and 313 ham respectively.

The quantity of sediment is distributed in the reservoirs as per Area – reduction method given in the IS code viz., IS 5477 (Part-II) – 1969, “Method for fixing the capacities of reservoirs”.

The quantity of sediment that would deposit in the reservoir (1) below MDDL (2) above MDDL (3) percentage of encroachment of live storage during anticipated life of the reservoir are noted below:

<b>I.</b>	<b>Punnamedu</b>	<b>50 years/ ham</b>	<b>100years/ ham</b>
a)	Below MDDL (+212.70 m)	299.2	597.8
b)	Above MDDL	81.6	163.1
c)	Percentage of encroachment into live storage during the life of reservoir	0.70	1.40
d)	New zero elevation (as per Area-reduction method)	115.652 m	116.697 m
<b>II</b>	<b>Achankovil Kal Ar</b>		
a)	Below MDDL (+192.18 m)	496.3	992.3
b)	Above MDDL	36.3	72.7
c)	Percentage of encroachment into live storage during the life of reservoir	0.23	0.45
d)	New zero elevation (as per Area-reduction method)	67.232 m	69.952 m
<b>III</b>	<b>Achankovil dam</b>		
a)	Below MDDL (+50.0 m)	117.9	214.4
b)	Above MDDL	194.8	411.0
c)	Percentage of encroachment into live storage during the life of reservoir	7.0	15.0
d)	New zero elevation (as per Area-reduction method)	41.012 m	43.101 m

## 7.2.4 Type and shape of reservoir

### i) Type of reservoir

A graph was plotted taking log of the reservoir depth as ordinate and log of the capacity as abscissa and the slope 'n' of resultant straight line was found to be 0.382, 0.3245 and 0.364 in respect of Punnamedu, Achankovil Kal Ar and Achankovil pumped scheme reservoirs respectively. The reciprocal of 'n' i.e., 1/n of the corresponding reservoirs works out to 2.618, 3.082 and 2.746 which are in the range of 2.5 to 3.5. Hence all the three reservoirs are classified as Type-II i.e flood plain and foot hill according to the classification of types of reservoirs by Borland and Miller.

### ii) Shape of reservoir

All the three reservoirs under this project proposal are of fern leaf shaped with narrow width with length extending from 10 to 23 km.

## 7.3 Life of reservoirs

It is assumed that the useful life of the reservoir gets terminated when its capacity is reduced to 20% of the designed capacity. On the above assumption, the useful life of Punnamedu, Achankovil Kal Ar and Achankovil pumped storage scheme reservoirs works out to 2187, 3733 and 392 years respectively.

However the life of reservoirs is considered as only 100 years for the purpose of sediment distribution and working out B.C Ratio.

## 7.4 Capacities

### 7.4.1 Capacities (Mm<sup>3</sup>) of the three reservoirs are given below

Sl. No.	Description	At the time of construction of dam	After 50 years of operation
<b>I Punnamedu</b>			
	a) FRL (+246.0 m)	208.0	204.2
	b) MDDL (+212.70 m)	89.5	86.5
	c) Live Storage capacity	118.50	114.6
<b>II Achankovil Kal Ar</b>			
	a) FRL (+210.0 m)	496.9	491.6
	b) MDDL (+192.18 m)	312.0	307.0
	c) Live Storage capacity	184.9	184.6
<b>III Achankovil pumped storage scheme</b>			

a)	FRL (+65.0 m)	30.6	27.5
b)	MDDL (+50.0 m)	2.8	1.5
c)	Live Storage capacity	27.8	26.0

### 7.4.2 Storages

The live storage capacity of Punnamedu, Achankovil Kal Ar and Achankovil pumped scheme are 118.5 Mm<sup>3</sup>, 184.9 Mm<sup>3</sup> and 27.8 Mm<sup>3</sup> respectively. The total demands considered in the preparation of working tables are 784.76 Mm<sup>3</sup> for the following purposes.

1)	Irrigation in Tamil Nadu	634.76 Mm <sup>3</sup>
2)	Downstream release during lean season to combat salinity intrusion	150.00 Mm <sup>3</sup>
	<b>Total</b>	<b>784.76 Mm<sup>3</sup></b>

For meeting the irrigation requirement, 75% dependability is considered.

Working tables are prepared based on the inflows at the dam sites for the period 1978-79 to 1990-91. From the working tables, it is seen that the reservoir is successful for irrigation in 85% of the years considered.

### 7.4.3 Evaporation losses in reservoir area

The evaporation losses in the reservoirs are taken as per the rate of evaporation losses observed at Idukki reservoir in Periyar basin. The monthly evaporation losses of Idukki reservoir are furnished below:

**Table 7.5**  
**Evaporation Losses of Idukki Reservoir**

<b>Month</b>	<b>Evaporation losses (mm)</b>	<b>Month</b>	<b>Evaporation losses (mm)</b>
January	77.5	July	31.0
February	84.0	August	31.0
March	83.7	September	45.0
April	60.0	October	55.8
May	86.8	November	51.0
June	30.0	December	71.3
		<b>Total</b>	<b>707.1</b>

#### 7.4.4 Flood absorption

The total flood absorption capacities provided at Achankovil Kal Ar and Achankovil pumped scheme reservoirs are 4.703 Mm<sup>3</sup> and 3.257 Mm<sup>3</sup> respectively, between FRL and MWL. The Punnamedu reservoir has no flood absorption capacity. The above three reservoirs do not have provision for flood absorption below FRL.

#### 7.5 Effect on sub soil water table

Water logging problem is not anticipated since the terrain of reservoirs and dam site areas are hilly and undulating with dense jungle.

#### 7.6 Area of submergence

The submergence area of all the three reservoirs lies in Kerala State only. The area of submergence consequent to the construction of dams are given below:

##### Submergence Area of Reservoirs

Sl.No.	Reservoir	Submergence area (ha)	
		at MWL	at FRL
1)	Punnamedu	440.000	440.000
2)	Achankovil Kal Ar	1269.850	1240.672
3)	Achankovil	339.250	323.000
Total		2049.100	2003.672
Say		2049.000	2004.000

##### 7.6.1 Land and Property to be acquired

The acquisition of land is to be done upto FRL, while the acquisition of houses and buildings are to be done upto MWL. Kozhenchery taluk of Pathanamthitta district and Pathanapuram taluk of Kollam district will be affected due to the submergence of the three reservoirs.

The classification of land coming under submergence is detailed below :

### Classification of Land Under Submergence

Classification of Land	Punnamedu dam	Achankvoil dam	Achankvoil Kal Ar dam	Total
	ha	ha	ha	ha
i) Forest				
Reserve forest	440.000	871.672	86.000	1397.672
Teak plantation	-	369.000	218.000	587.000
ii) Cultivable land (unirrigated)	-	-	19.000	19.000
Total	440.000	1240.672	323.000	2003.672
			Say	2004

The area mentioned under submergence is inclusive of the area occupied by river portion which is insignificant.

#### 7.6.2 Submergence ratio

The submergence area of both Punnamedu and Achankovil Kal Ar projects lies in forest. A cultivable area of 19 ha only is coming under submergence under Achankovil pumped storage scheme reservoir. Considering the culturable command area of 101555 ha under the project, the submergence ratio works out to be  $1.9 \times 10^{-4}$ .